Software Frameworks for Rapid Mission Development

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Software Frameworks for Rapid Mission Development

Agenda:
• GomSpace at a glance
• Hardware product port-folio
• Software frameworks
  • Cubesat Space Protocol
  • Command and Datahandling
  • Attitude Determination and Control System
• Mission Operations Platform
• Licensing models and availability
GomSpace at a Glance

Origins

• A start-up company based on research done at Aalborg University 2001-2007, e.g. AAU-Cubesat launched in 2003
• Established in 2007 as a private limited company

Locations and staff

• Aalborg, Denmark
  • 5 full time staff, 3 project staff
  • 2 interns, 1 phd student
• Palo Alto, California
  • Co-located with the Danish Innovation Center
  • Legal subsidiary under establishment
  • Adding staff in Q3 2011

What we do

• Nano-satellite subsystems and software frameworks
• Nano-satellite complete platforms (customers, research)
• Consulting and system development within the space domain, e.g. for ExoMars and re-entry missions
GomSpace Hardware Products

Product Philosophy
- Based on flight experience
- Interoperable with products from other vendors
- Easy integration - towards plug’n’play

COTS Components
- Help you to focus on mission objectives
- Reduce the design space challenge
- Reduce risk - technical and schedule

CAM
3 Megapixel Camera System

Solar Cells
Integrated Solar Panels w/ sun sensor and gyro

BATT
Li-Ion Battery Module 8.4–16.8V 1800–3600mAh

COM
Spacelink Communication Systems

ADCS
Attitude Control System w/ PWM drivers

OBC
On-Board Computer Systems

EPS
Power Conditioning and Distribution
COTS = Mission Focus!

Cubesats are still a challenge
- Small: yes - simple: not really!
- Many technical disciplines needs to be mastered concurrently
- A lot of modules and interfaces needs to come together in the integration phase

Software is especially challenging
- “but it is just software” or “we can handle that in software”
- Problems only starts showing up when integration starts (which is always too late)

What COTS can do for a project (HW & SW)
- Accelerate schedule, reduce risk
- Focus resources on novel development, not re-inventing wheels
- Allow integration testing to start early

Missions will have different COTS requirements!
GomSpace Software Overview

Modules/Frameworks:
- CSP: Cubesat Space Protocol
- CDH: Command and Datahandling
- ADCS: Attitude Determination and Control
- MOP: Mission Operations Platform

Implementation of on-board software:
- Implemented in C (defensive programming)
- Runs on top of FreeRTOS operating system
- Written for portability (especially ADCS)
The Cubesat Space Protocol (CSP)

Technical Objectives
- Allow a service oriented network topology extending a network transparently across space and ground segments.
- Ease integration between subsystems - plug’n’play.

Current Compatibility
- Operating systems: FreeRTOS, POSIX
- Architectures: ARM, AVR8, AVR32, x86
- Interfaces: I2C, CAN, RS-232, CCSDS, HDLC, loop-back

Status
- Used in all GomSpace systems
- Core parts open source (Google code)
- Collaboration encouraged

http://code.google.com/p/cubesat-space-protocol/
Command and Data Handling Framework

Features

- Journalized filesystem implementation
- Robust file transfer protocol (on top of CSP)
  - Authorization supported
  - Encryption supported
  - Compression supported
- Remote software upload and management
- Flight planner
  - Command authorization & execution
  - Command sequence management
  - Mode management and autonomous functions
- Autonomous house keeping collection with file back-end
- Distributed Logging system
- Mission parameter database server
Attitude Determination & Control Software Framework

Features

• Ephemeris models: orbit, magnetic field, sun, earth rotation, eclipse
• Quaternion based Unscented Kalman Filter for attitude determination
• De-tumbling control modes (B-Dot)
• Nadir and inertial pointing modes
• Matlab model for test and tuning of parameters

Compatibility

• Initially only GomSpace products:
  • Panels: magnetotorquer, sun-sensor, gyro
  • OBC: magnetometer, PWM drivers, processor
  • Drivers for other hardware parts will be developed

Performance

• Determination accuracy: 3-5 degrees
• Pointing accuracy: 6-10 degrees
Mission Operations Platform

Main Features

• Robust communication with satellite including file transfer
• Plug-in for each subsystem (incl. SW systems)
  • Graphical representation for TM
  • Plotting functions for historical data
  • Graphical commanding (TC)
• Flight planner to build, edit and upload flight plans including scripting for autonomous functions
• Activity logging and data storage to SQL database
• Software upload function
Mission Operations Platform - Example
Licensing Models and Availability

**Licensing Options (TBC)**
- Source - license
- Full source disclosure
- Per mission fee
- One year support and updates included
- Binary license
- Binary library precompiled for NMA712 + skeleton code as source
- Per mission fee
- One year support and updates included

**Availability**
- May: Pricing and overview information on homepage
- June: Extensive documentation packages available
- July: Products available for purchase

Software is currently in testing with select customers.
Contact Information

www.gomspace.com

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